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EXPERIENCE has taught our predecessors that the first paths the young editor of a college journal encounters are by no means strewn with rose blossoms, but, upon the other hand, are usually thickly beset with deep-cutting and hindering thorns. They have therefore adopted the custom of electing the new board some time before the last issue of the year, thus giving ample opportunity for the new men to profit by the experience of their predecessors in avoiding the thorns—or, at least, getting scratched as little as possible by them.

Following this custom a meeting of the board was held May eleventh, at which the following board was elected for the year 1903-1904.

L. A. Touzalin, ... Editor in Chief.
George Benson, ... Assistant Editor.
Fred B. Lewis, ... Reviews.
Howard A. Mullett, ... Alumni.
J. O. Bland, ... Athletics.
Charles B. Falley, Carl Wischmeyer, } . . . . Local.
Leo F. Dorn, ... Artist.
Ralph C. Blanchard, . . Business Manager.

The Editor in Chief, Mr. Touzalin, has been the Local Editor from the Junior Class the past year, and has shown himself to be especially well qualified for and deeply interested in editorial work. He is a man of untiring energy and great versatility, so we are confident in predicting a most successful year for the Technic with such a man at its head.

Mr. Benson, the Assistant Editor, has been the Local Editor representing the sophomore class the past year. He is an easy and interesting writer, and one of the most popular fellows among the students. With such qualifications he should easily succeed in giving the readers of the Technic a full and interesting Rose Leaves department next year.

Mr. Lewis, who will have charge of the Reviews, has served the Technic in the capacity of both Local and Assistant Editor. In view of his experience and adaptability he has been elected Editor of the 1905 Modulus, which is to be published next year. He is a broad reader and we are sure he will get up a wideawake and instructive department of reviews.

Mr. Mullett, is without experience upon the Technic staff, but has a wide acquaintance among the Alumni. Consequently he will have but little trouble in obtaining articles for the Alumni department.

Mr. Bland's work of the past few months speaks for itself in showing his ability to edit the department alloted to Athletics.

The Local Editors, Messrs. Falley and Wischmeyer, are two new men selected because of qualifications and experiences that are believed to well fit them for such a position.

The Artist, Mr. Dorn, needs no introduction or recommendation to the readers of the Technic, for its pages have often been beautified and its articles illustrated with his sketches.

Mr. Blanchard, the Business Manager, has filled the position of Assistant Business Manager since February, in which capacity he has been of inestimable service to the Manager. With this experience and his wide acquaintance among the business men of the city the financial side will be well looked after.

SPEAKING of finances recalls to mind the fact that the past year has been one of the best the Technic has ever experienced, at least from a financial point of view. Usually it has been necessary for the Technic to call upon the Council for a special appropriation, with which to settle up its actual running expenses. Owing, however, to the good management its affairs have received in the hands of Mr. Garrettson, it will not only be able to pay all of its running expenses, which have been somewhat heavier than usual owing to the large amount of illustrating that has appeared this year, but has added two typewriters to its stock.

The sources of revenue the past year have been:

Student's Council, ...	$287.70
Alumni Subscriptions, ...	92.00
Advertisements, ...	431.50
Total, . . .	$811.20

This shows that out of nearly three hundred graduates only ninety-two subscribe for the Technic, less than one-third. This seems to us to be a very small per cent indeed. Surely a graduate does not loose interest in his *Alma Mater* so soon.

ONCE more the commencement season is rapidly drawing near. That time that calls forth, in the college man about to receive his degrees, such mixed feelings of joy and sadness. Joy, that he has successfully completed his work in college and is about to enter some branch of the world's work, far better equipped to meet the vicissitudes and enjoy the pleasures of life than his less fortunate brother. Sadness, because it means the breaking of fond ties, the desertion of beloved haunts, and the necessity of making new associations and friendships that can never take the place of those of our college days.

At Rose we are naturally interested in who is to deliver the Commencement Address, and in which one of our elder brothers, that has trod the same paths over which we have been toiling the past four years, is to tell us of his experiences and allow us the benefit of his advice.

The Commencement Address this year will be delivered by Dr. R. S. Woodward, Dean of the Faculty of Science, Columbia University. Dr. Woodward is a man of no little renown, a polished and pleasing public speaker. He has chosen as his subject "Education and the world's work of to-day," so we can look forward to a most interesting and instructive address.

The Alumni Address is to be given by Dr. Charles E. Mendenhall, who graduated from Rose in 1894, afterwards receiving the degree of Ph. D. from Johns Hopkins University. Dr. Mendenhall is at present Assistant Professor of Physics, University of Wisconsin.

IT is indeed gratifying and pleasing to have a Board of Managers, at the head of the Institute, that is so ready and willing to do the handsome thing, as did the board in regard to the recent senior trip to Pittsburg. Every request was granted, and $200 was allowed to assist in defraying the expenses.

The reception that the Alumni gave us in Pittsburg makes one rejoice that he is soon to be one of them. Every Alumni within a radius of 100 miles of Pittsburg left his business, and devoted his time and means to making every phase of the trip a success, and they certainly did. They are all jolly, good fellows, every mothers one of them.

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The members of the Institute, on Wednesday, April 29, had the pleasure of listening to a very interesting address, on "The Organization of Great Industrial Establishments," by Mr. A. L. Rohrer, Superintendent of Works, General Electric Company, Schenectady, New York.

Mr. Rohrer reviewed the organization and merging of the several smaller companies into the General Electric Company. He threw upon the screen a chart, which looked very much like a pedigree sheet, that showed the division into departments from the President, through the various Vice Presidents, Superintendents and Engineers down to the workmen in the shops. He pointed out the various schemes by which the stage of development of the smallest part of a machine could easily be determined by the heads of the departments. His talk was illustrated with many lantern slides of views about the various establishments of the General Electircal Company. In closing, Mr. Rohrer told of the work and opportunities for technical graduates.

Photometrical Measurements.

By PROF. C. L. MEES.

THE rating of artificial light sources by photometrical measurements has of late years received much attention. To the busy engineer the mass of literature seems so formidable, the opinions so conflicting, that he is tempted to consider the whole subject as hardly worth wasting time upon; he is tempted to humorously express himself as not caring to play a "game not worth the candle."

From the practical point of view there will be more or less of inexactness in photometrical measurements, for the object is to measure a sensation effect, complicated by complex physiological conditions, and not a comparatively simple physical quantity. Physical defects in the eye, idiosyncrasies, physical condition of the observer, will be important factors and must become sources of error. Under such conditions approximate accuracy becomes a matter of judgment more than precision of methods. More dependence must be placed upon judgment and experience than upon refinement of instruments, for the greatest source of error is to be found in the former.

Reference is had only to the practical aspect of the subject, and not to photometry as a phys cal laboratory study or scientifical problem.

For the convenience of engineering students who may not have time to study systematically and in detail the mass of periodical literature, a few suggestions are made and a few terms defined which have been introduced of recent years, so that they may be able to read recent contributions with a reasonable degree of comfort without losing too much time in searching for the meaning of unfamiliar terms.

The definition of illumination, or rather lack of precise definition has given rise to obscurities in practical photometrical measurements. The light sensation which enables us to distinguish and discriminate outline and detail as well as the color of objects, practically, becomes the criterion of *illumination*. This does not depend solely upon the quantity of light, but upon the quality, and is greatly influenced by the character of the object to be illuminated. In a general sense, it requires the study of not only the efficiency of the light source in illuminating a white object or any one definite surface or form, but its efficiency for the purpose intended.

The quality and distribution of the light become of the greatest importance. The engineer must exercise mature judgment to obtain the best result, and the lighting test must be made in such a manner that its usefulness for the intended purpose may be determined.

As an illustrative case, suppose the light is to be used mainly for reading, and a comparison of different sources for the purpose of obtaining their relative efficiencies is desired. The ordinary Bunsen Photometer or Paraffine Wedge, or the more refined Lummer Bradhun Photometer, may be used. Because of difference in color of the light, great experience is required with these devices to make a photometric measurement accurate within four per cent, using any accepted standard. The net result is the comforting knowledge that the lamp or source of light has a certain candle power, but whether because of, say, a greater candle power it is a really better source of light, is by no means settled.

The physiological effect produced by the light under the conditions of use is a factor not to be overlooked. The fatigue effect upon the eye, due to contrast and diffusion depends largely upon the character of the light.

For a fair approximation to a test for the purpose indicated, the simple method of a reading photometer has been found useful, and is comparable in accuracy with many elaborate photometric devices. An ordinary tape line and a table of logarithms constitute the apparatus. A table of logarithms was selected because of convenience, while the fact that, to the ordinary reader, it is not of such absorbing interest that he is likely to strain his eyes unduly, is useful. Again, as it is not general to commit a whole table to memory, you cannot guess the succession of numbers very well or anticipate them from succession, the latter an important factor.

The source of light is allowed to illuminate the page of logarithmic tables placed at right angles to the line joining the book and the light source. The eye is then placed at a convenient distance, say 20 inches, from the page, the axis of the eye at a convenient but constant angle to the page and back to the light. The table of figures is moved away from the light source, the eye being kept in a constant position in reference to the page, until the successive figures can just be read. This observation can be continued for about fifteen seconds. The eye is rested for about a minute, a record of observations taken, etc., for a number of readings. The distance between light source and the page of tables is measured each time. A similar series of observations is made upon the source of light to be compared and the ordinary photometric law that the intensity is inversely proportional to the squares of the distances is applied. An accuracy about equal to the Bunsen Photometer can be obtained. In addition to the measure of intensity thus obtained, as by ordinary photometric methods, the relative fatigue effect of the two sources becomes apparent. The light which fatigues the eye most will be recognized by the necessary shortening of the distance between book and light in successive measurements. The rate of change in these distances gives a fair quantitative approximation to the fatigue effect.

This procedure indicates how relative illuminating values may be determined by simple means often more effective than elaborate photometric methods.

For determining the suitability and value of an illuminant for special purposes, equally simple methods quite as effective as the one used for illustration can generally be devised. When the question of economy enters into the problem, it becomes more complicated. In most of such cases a fair comparison can only be made between sources of light of similar character. For instance, the relative economy of several different incandescent lamps can be determined with considerable accuracy by the use of refined photometric apparatus and accurate electrical measurements. The more the sources of light differ in character, the more unsatisfactory do such comparisons become. Considerable error may arise in the application of the law of inverse squares in comparisons between sources of light presenting different illuminating areas. Where the area is large the law of inverse squares does not hold for short distances between the light source and the object. In the ordinary practical applications, the light diffusion from larger areas of less intrinsic brightness is often advantageous.

By photometric measurements, as ordinarily made, the absorption effects of globes, chimneys, etc., records great absorption or loss of light, while in practice their diffusive effect may be very advantageous in causing a departure from the law of inverse squares, the diminution in intensity for the relatively short distance taking place less rapidly. A clear glass chimney or globe may in certain regions cause a very wide departure from the ordinary law by reflection from the surface and by lense effect.

The specification of a certain illuminant in terms of candle power for practical purposes is useless unless very definite conditions are specified. Parenthetically it may be said that this method of specification in contracts for arc lamps has given rise to more trouble than all other specifications combined in lighting contracts. The only form of specification for arc light capable of rigid enforcement is to specify the amount of electrical activity in the arc with prescribed quality of carbons. This is capable of accurate and ready measurement, and will ensure a very definite illuminating power for the lamp.

Attempts have been made to thoroughly standardize light measurements by perfection of units and definition of terms in standardizing laboratories as well as by conference committees. So far no very great unity of practice has resulted. The Geneva Conference in 1896 adopted the $\frac{1}{20}$ Violle unit as a standard, and called it the Bougie Decimale.

The Violle unit, it will be remembered, is practically defined as the quantity of light emitted in a normal direction by one square centimeter of the surface of molten platinum at the point of solidification. (The value of this standard is very questionable.) The Bougie Decimale is equivalent to .925 British candles.

The British candle has been in this country the most commonly used unit and is meant when candle power is spoken of unqualifiedly. It is defined as the light emitted by a spermaceti candle consuming two grains of sperm per minute from a three stranded, plaited cotton wick, with many other specifications. It is also equivalent to .945 Heffner units. The Heffner unit burns amylacetate from a carefully specified lamp. It is the standard adopted in Germany. Its use is rapidly extending. The German Reichanstaldt has made an exhaustive study of the lamp, and finds that it is reliable to within two per cent when constructed reasonably accurately and properly used. Its operation is satisfactory and simple. It is also relatively inexpensive. At this conference certain terms were defined which are coming into quite general use.

The unit illumination of a surface is the amount of illumination of that surface produced by one Bougie Decimale at the distance of one meter. British engineers still define the unit illumination as that produced by one candle at the distance of one foot.

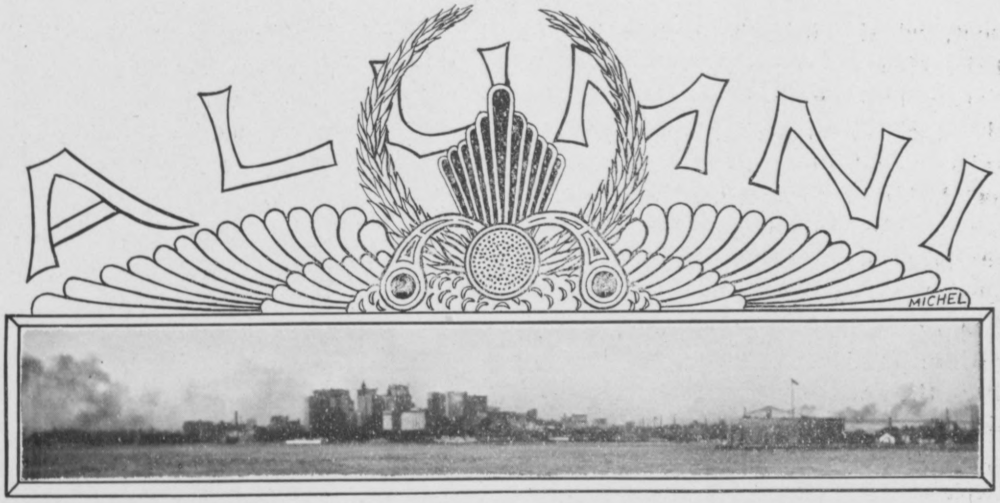
Other definitions adopted are as follows:

Quantities to be expressed.	*Name of Corresponding Unit.*
Intrinsic brightness " brilliancy Candle Power.	Bougie Decimale.
Illumination of surface	1 Lux equals 1 Bougie Decimale at the distance of 1 M.
Quantity of Light Total Light in Pencil Luminous Flux	1 Lumen equals the flux due to one Bougie Decimale within a solid angle equal to unity. The total light flux from one Bougie Decimale equal 4π lumens. 1 Lumen, spread over one square meter equals 1 Lux.
Brilliancy of Flame Luminosity of Flame Specific of Luminosity	1 Bougie Decimale per square centimeter of luminous area.
Quantity of Light	1 Lumen hour.

The luminosity of the electric arc with good carbons is approximately 15,000 Bougie's Decimale.

This brief mention of photometrical standards and terms is given for the convenience of readers of literature.

The whole subject of photometry is one of perplexing difficulties, yet full of interest and its study, if not very useful from the purely commercial and practical point of view, is profitable to the student.



The Physical Structure of Metals and Alloys.

By J. J. KESSLER, '97.

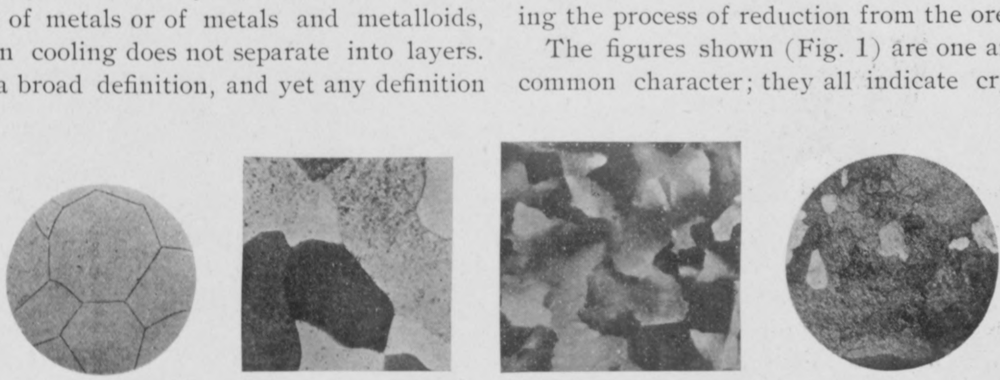
[Abstract of Paper read before the Engineers' Club of St. Louis, April 15th, 1903.

THE subject which is to be considered under title of this paper is usually treated as "The Microstructure of Metals and Alloys." This is a little misleading, as it implies that this is one of the particular kinds of Physical Structure which is being involved, whereas, as a matter of fact, the whole anatomy or architecture of the metal or alloy is being considered and the microscope is concerned only in that it is an indispensable instrument of research on account of the size of most of the structural elements.

An alloy is defined by Roberts Austin as any mixture of metals or of metals and metalloids, which on cooling does not separate into layers. This is a broad definition, and yet any definition which is not as broad, fails to include many substances, the most important of which is Cast Iron, and which cannot be defined as a solid solution nor a chemical compound, but which is a true alloy in the sense of the definition. In fact, brass or bronze are not more truly alloys than is Cast Iron.

The first structural elements to be considered are those present in pure metals. It is well to call to mind here that chemically pure metals are not to be found as engineering materials. They have all to a greater or lesser extent associated with them impurities which were originally present in the ore or which have been acquired during the process of reduction from the ore.

The figures shown (Fig. 1) are one and all of common character; they all indicate crystalline



Iron. Platinum. Tin. Lead.

FIG. 1. Illustrating the Crystalline structure of Pure Metals.

arrangement, whether it be the metals, lead or tin, or at the other extreme of physical properties, antimony or bismuth, not shown, it may be seen that each metal is an aggregate of crystalline grains bounded by definite surfaces, and that no metal, however pure, may be said to be homogeneous. Each is an aggregate of homogeneous grains or crystalline units, homogeneous in themselves but possessing limited volume and bounded by surfaces, the forces pertaining to which are of much different character than the forces within the grains themselves.

The distinctive differences between metals, therefore, is not one of crystalline character. We cannot explain the physical difference between lead and antimony, for instance, by stating that one is crystalline and the other not. All metals are truly crystalline; the difference between them must be found in differences in the properties of their crystalline grains and in the forces existing between the crystalline grains.

An interesting point comes up in this connection, and this is the effect of stress on these pure metals. When a metal is yielding to stress and the deformation has not reached the elastic limit, no change in the structure of the metal can be recognized under the microscope. When, however, the elastic limit has been reached and plastic yielding of the metal begins, the change is indicated in a very characteristic way.

FIG. 2. Lead—Stressed until plastic yielding has commenced.

Figure 2 shows quite a different appearance from any structure which has been observed. Large crystalline grains are shown as before, but across the face of each grain will be seen a number of series of parallel lines running across the entire surface of each grain, but each series ending abruptly when the boundary of the grain has been reached. These series of parallel lines are not scratches on the surface of the metal, and only begin to appear when the elastic limit of the metal has been reached by stressing.*

This appearance of parallel lines in the structure of a metal when the yield point of the metal has been reached by stressing, is common to all metals which have been thus far examined. Closer examination of the surface of the metal, reveals the fact that these lines represent the connecting surfaces between parallel planes which are at slightly different levels.

An ideal cross section of such a strained metal would be represented as shown in Figure 3.

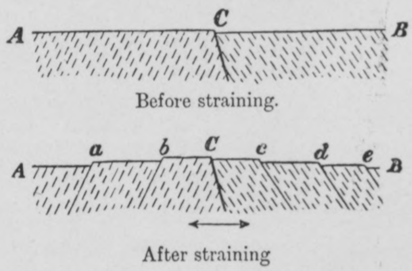


FIG. 3. Ideal cross-section of strained metal.

Strain in a metal, therefore, is not a question of homogeneous shear as in the case of a liquid, but takes place by the successive slipping over one another of the iner-crystalline grains. The most severely strained metal still retains its crystalline structure, the effect being to elongate the crystals in one direction as in the case of rolled or hammered steel, and this is what gives the metal its fibrous qualities. The use of the word fibrous in connection with a metal is only correct, therefore, in that it indicates either crystals elongated by stress, or impurities present in the metal which are elongated by stress. This is invariably the case in Wrought Iron, which is only fibrous when it contains elongated crystals or other structural elements, or because it contains elongated portions of slag or other impurities.

Pure metals are not used in the arts, however, to the extent to which mixtures of metals are used.

Mixtures of metals, which on cooling do not

* Ewing and Rosenhain, Phil. Trans. Roy. Soc. CXCIII, p. 353.

separate into layers, may contain three (3) different kinds of constituents:

1st, Homogeneous Solid Solutions.

2nd, Distinct crystals of one substance distributed through another.

3rd, Liquid Solutions which on cooling have frozen into solid solutions, but which, at the instant of freezing, have separated into alternate layers of the different constituents.

These three different kinds of constituents are illustrated in the following figures. (Figure 4).

FIG. 4. Homogeneous solid solution of Silicon and Iron. (4% solution).

The first case is represented by the Silicon Iron Alloy which is seen to be made up simply of crystalline grains, the Silicon being diffused through the mass of iron, the whole being a true solid solution of Silicide of Iron in solid iron, which cannot be separated from the iron by mechanical means, whose composition may vary uniformly with certain limits, and which is, therefore, a true solution.

The properties of such an alloy will be similar to those of the pure metal, and will depend on the properties of the individual grains, and on the forces existing between the grains.

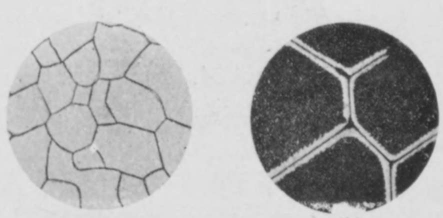
In the case of such an alloy it can be predicted that for any given change in the percent of silicon present, no radical change in the properties of the alloy over that of the pure metal will take place; for instance, if the electrical conductivity of the metal be represented by a certain figure, the addition of .01, .10 or even 1.00% of silicon, will not materially effect this conductivity.

The second class of alloys may be represented by the micro-photographs of Pig Iron, and Bismuth Copper Alloy (Fig. 5). In this case, entirely distinct constituents are seen in different parts of the metal. If the first class of alloys mentioned be compared to a solution of salt in water, the second may be represented by the case of a solution of salt and water which has been cooled to a point where solid salt has been separated from the solution. This represents by far the most common form of alloys. The homogeneous molten mass in cooling separates out different constituents which remain diffused through the still molten mother liquor, which finally freezes itself, forming the solid alloy. The properties of such an alloy may be entirely different from those of the pure constituents.

The micro-photograph of the Bismuth copper alloy contains .5 per cent Bismuth. This Bismuth does not form a solid solution as in the case of the silicon iron alloy; but a small amount of

(a) (b)

Gray Cast Iron. (a) Quickly cooled exterior portion of casting. (b) Slowly cooled interior portion of casting. Both of same chemical composition.



(a) (b)

Showing effect of small amount of Bismuth in pure Copper. (a) Pure Copper. (b) Copper with Bismuth Copper Eutectic between the crystalline grains.

NOTE.—(a) is printed from a negative and (b) from a positive, so that the light and dark portions of (b) should be reversed to be comparable with (a).

FIG. 5. Showing Alloys containing distinct chemical and physical units imbedded in a solid matrix of another substance.

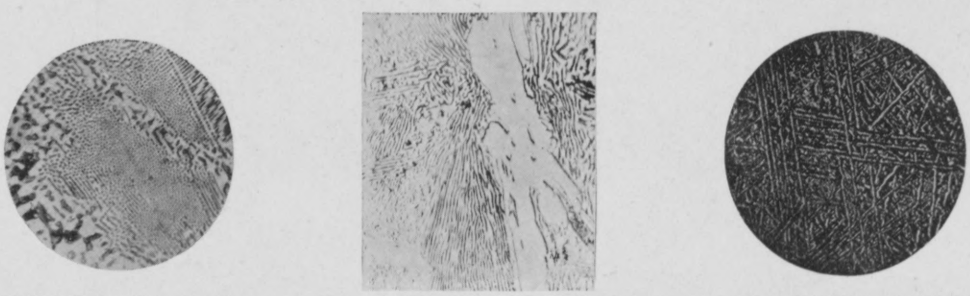
Bismuth unites with a large amount of copper to form a eutectic alloy (see next paragraph), and this alloy is forced out of the growing crystals of pure copper, until finally in the solid alloy it forms a shell of brittle Bismuth copper eutectic around each grain of copper, thus giving the characteristic brittleness and shortness to the metal. In the case of such alloys, it can be predicted that for any given change in the percentage of impurity present, a radical change in the properties of the alloy over that in the pure metal will take place.

For instance, the electrical conductivity of copper being represented by 100, the addition of .001 per cent of arsenic reduces this to 99.5 or the addition of .010 per cent reduces the conductivity to 95 3, the arsenic forming with copper an alloy similar to the Bismuth copper alloy shown.

There is still another structural component of alloys, and although seldom constituting the entire structure of any alloy, they form a very important structural constituent of most alloys. When a molten homogeneous solution of metals is allowed to cool, as has been stated, different constituents which become insoluble at certain temperatures are reached, separate out and become structural components of the finally solidified alloy.

Whether such action has or has not taken place, however, there comes a point where the remaining solution freezes as a whole. If the metals can form a solid solution as is the case with the first class of alloys, this will be done. If the constituents are not mutually soluble to one another, a separation will take place at the instant of solidification, and the resulting alloy will be found to consist of alternate layers of the different separated constituents. A strong magnification is required to resolve this kind of structure. This alloy is always characterized by the fact of its having the lowest melting point of any of the whole series between the metals. It is in fact, always a solidified mother liquor. The composition of the eutectic alloys of any two metals may be ascertained either by analyzing the alloy which shows the proper eutectic structure, or by studying the freezing point curves of different alloys composed of the same metals but of varying composition. Fig. 6 shows the eutectic alloys of several metals.

Every alloy, therefore, will consist of either one, two or all of the three different constituents named above; each combination of metals forming its own characteristic solid solutions, chemical combinations, eutectic alloys, etc. The size and arrangement of these structural units being a function of the temperature from which the alloy is cooled, the rate of cooling and the work done on the alloy either while it is being cooled, or after it has reached temperature equilibrium.



Iron Phosphorus Eutectic Alloy. Iron, Carbide of Iron Eutectic Alloy. Silver Lead Eutectic Alloy.

FIG. 6.

It must always be remembered that simply heating a series of alloys with the same chemical composition, to the same temperature, does not necessarily imply that the alloys will be in the same structural condition; this will be the case only when the metals have been held at the required temperature long enough for complete equilibrium to take place through diffusion, etc.

Very important results have been obtained by studying the physical structure of alloys; two instances will be given where good has been accomplished in entirely different branches of metallurgy.

In the first instance it has been found that there is only one temperature from which cast steel .29 % carbon, may be annealed to give greatest tensile strength combined with the greatest ductility; this has been found to be the temperature which gives the smallest crystalline grains on annealing. The different results obtained by annealing from different temperatures being shown in Fig. 7, both as effecting the size

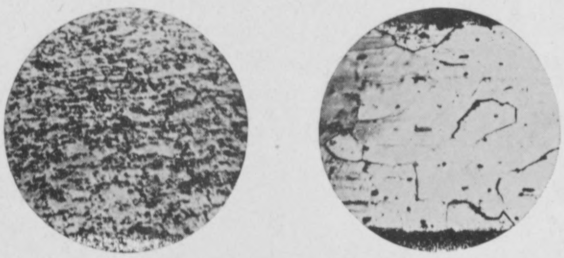


FIG. 8. .07% Carbon Electrical Sheet Steel, showing proper and improper annealing.

of the crystalline grains and as effecting ductility, as measured by the bending test, and as shown by the figures of the Test Bars above the microphotographs, each one having been bent to the angle shown before breaking occurred.

The second field in which the microscope has proved to be of great assistance, is in studying sheet electrical steel, .07 % carbon, with reference to the relations between its physical structure and its magnetic properties. It has been found that the lowest hysteresis is found in steel which contains the best developed crystaline grains, and these are only developed when the steel has been subjected to a definite heat treatment.

These are only two instances of a large number of cases in which the microscope has been found to be useful in studying the physical structure of metals and alloys, a feature which is becoming to be recognized as being of quite as much importance to the knowledge and control of the properties of these materials as is chemical composition.

FIG. 7. Microphotographs of Cast Steel .29% Carbon. Showing relation between Structural and Physical properties.

Prepared by MR. C. H. CARR. Chief Chemist of the American Steel Foundries Co.

The Broadway Transportation Lines, New York City.

By A. EUGENE MICHEL, '03.

THERE is no place in the world where rapid transit is of more importance than in Greater New York. The enormous concentration of business on the south end of Manhattan, and the astonishingly rapid growth of this part of the city have kept the transportation companies constantly overtaxed. The ever increasing traffic has necessitated a series of improvements, of which the subway is the latest.

Of all these improvements, the Broadway surface lines stand out with a distinct individuality. Running, as they do, through the most crowded districts, their cars are operated with the heaviest patronage and amidst obstructions from teams, etc., which is simply indiscribable. Before 1890 these lines and others next in importance were operated with horse cars. About that time agitation was started which ended in their conversion to the cable system. A station of 2000 H. P. was installed in the basement of a down town business block. Beneath the street was placed a subway 100′ long and 40′ high in which were located the massive inclined sheaves which directed the cables from the driving wheels in the engine room to the vertical sheaves on the overhead beam, and to the arched cableways, immediately under the grip slot (No. 1). The old tracks were supplanted by heavier ones and the cableway. Horse car drivers were trained to

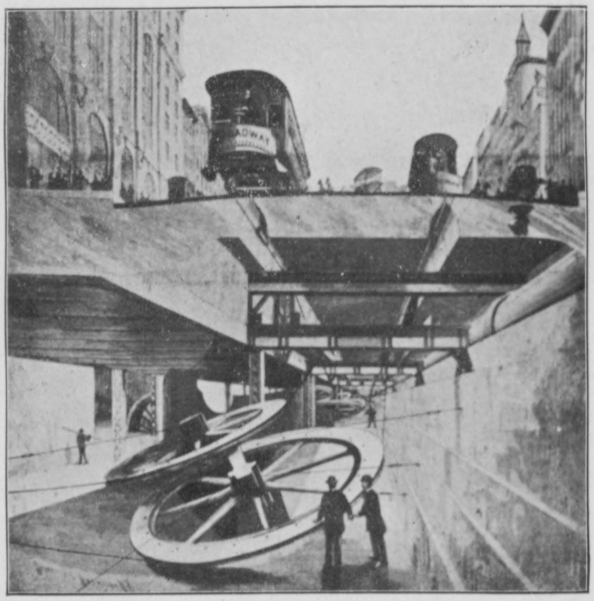


Fig. 1.

manipulate grips and brakes. Cable cars began running slowly between the horse cars. The time was quickened as the men became experienced, and the old cars were withdrawn entirely.

But in its short lifetime the Broadway cable system proved itself unsuitable to public needs and capable of serious accidents. Once a gripman found it impossible to release the cable and his car went tearing down Broadway, clearing, with a propelling force of 1200 H. P., everything in its path. It was stopped only by the turning off the steam at the power house and bringing the whole system to a standstill. On examination of the grip, it was found that a hitch had formed in the cable. (No. 2). The grip had to

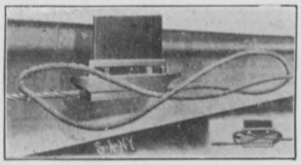


FIG. 2.

be broken and removed from the slot and the car towed back to the power house. The cable was flexible enough to pass around the sheaves then, but too rigid to release the grip.

Another case in which a car acted in the same manner was found to be due to an entirely different cause. When the power-house had been signaled and the engines stopped, an examination of the cable showed that one strand had been broken, and by catching on the grip, 1500′ of this strand had piled up behind the grip. (No. 3). Traffic had to be suspended for several

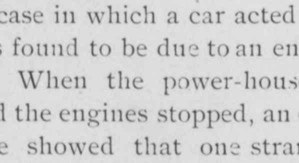


FIG. 3.

hours until the cable could be put in running condition by removing the loosened strand.

The most disagreeable feature of the cable cars was the jerky effect so noticeable in starting, stopping and turning corners. Owing to the fact that this class of cars can run at only one speed, passengers who were not fortunate enough to get seats were compelled to go through violent involuntary gymnastics which would have done credit to a base ball player trying to reach second. In one place where the tracks made a reverse curve, this effect was so bad that people were thrown from the cars daily. Fatal accidents occurred regularly, and the spot fairly earned its title of "Dead Man's Curve." It became the subject of violent newspaper attacks, and finally the company was sued for maintaining a public nuisance. Of the remedies proposed, two are worthy of note. One project consisted in putting in a very slow running cable at this spot. The other, in building a subway under Union Square, and thereby eliminate the curves entirely. But about this time the conversion of the lines to underground electricity put a stop to all trouble here. Under the present system, cars run around these curves at the perfect control of the motormen, and "Dead Man's Curve" is now no more than a spot interesting for its past history.

As late as 1897 the president of the Metropolitan Street Railway Co., deemed cables on Broadway superior to an electric system, but during that year the Lenox Avenue line was converted to underground electricity. This experimental line was so successful that it led to the complete removal of the cables. For some reason, the underground trolly system was not considered practical. Only two roads, and those in Europe, were successfully operated in that way. The greatest difficulty was feared from the entrance of dirt, water and snow into the conduit, destroying insulation and involving other troubles too numerous to mention. Ingenious devices have been used to prevent these difficulties, but in New York dependence has been placed in simplicity and perfection of construction, rather than in protective arrangements.

On Broadway the whole of the original cable construction was available, and the changes were confined to laying feeder ducts at the side of the tracks, and bolting conductor rails in the slot. Horse car tracks, on the other hand, had to be entirely removed to make way for the massive standard heavy rail. This standard rail, which weighs 107 lb per yard, is by far the heaviest ever used for this purpose; the largest rail used on the New York Central (steam) being only 100 lb per yard.

In laying the ducts, the bottom of the trench is leveled and covered with from six to ten inches of concrete. The ducts, which are of tile or cement lined iron pipe. are then arranged symmetrically in layers, and cement run between them to bind the mass together. (No. 4).

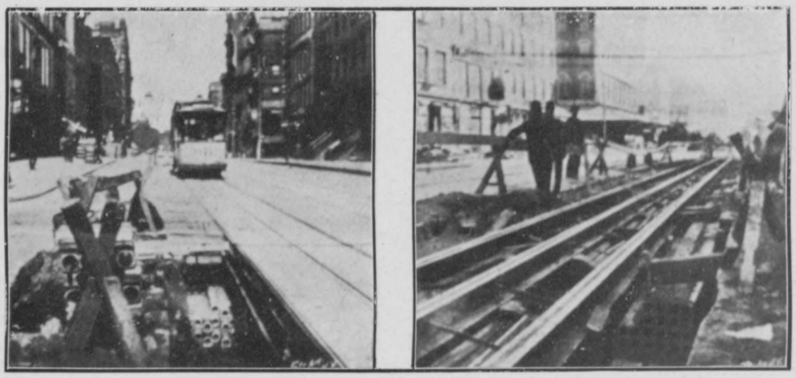


FIG. 4.

The conduit proper is the same as for the cable road, in order to utilize the old construction, and to allow the insertion of cables if the electric system was not successful or desirable.

The conductors consist of two lines of two-inch wrought iron pipe in the earlier, and of T shaped rails in the latter construction. These are suspended below the cable slot by means of insulators attached to the lower flanges of the slot rails. The insulator consists of a circular cast iron cup provided with lugs by which it is bolted to the slot rails. Within this cup is another of porcelain, which is held tightly in the iron cup by cement. The porcelain cup holds an iron shank to which the conductor T rail or pipe is bolted. (No. 5).

To enable the conductor rails and their supports to be put in place, two "hand hole boxes" are located one on each side of the slot, at every fifteen feet of the Broadway track. The conductor rails are in thirty foot lengths, so that they may be slid into the conduits at the hand holes.

The track rails have nothing whatever to do with the electric circuit; the current being supplied from the two lines of conductors beneath the slot. As none of the current enters the ground there is no possibility of danger from electrolysis. The current is conveyed to and from the motors by a device called the "plow," which reaches down through the slot and to the conductors. (No. 5). The shank of the plow

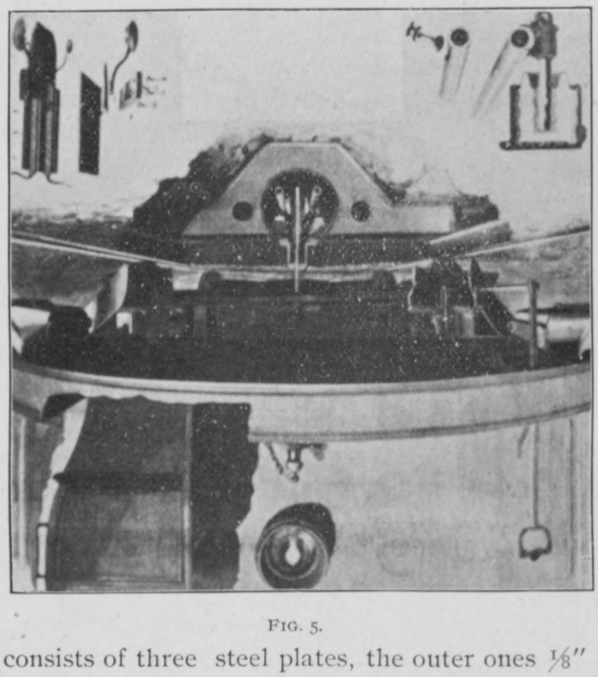


FIG. 5.

consists of three steel plates, the outer ones $\frac{1}{8}''$ thick and the inner one $\frac{3}{16}''$. The conductors, which are wrapped copper ribbons, are carried down through the plow to the contact shoes or wipers, connection being made between them by flexible cables. The shoes are round and of cast iron and measure $4''$ by $\frac{1}{2}''$. They are kept in contact with the conductor rails by means of side steel springs which keep the shoes 8″ apart when free and 6″ when in contact with the conductor rails. It has been found that a pressure of six or seven pounds is sufficient to insure good electrical contact between shoes and conductors.

The lines are operated with uniform success during summer and winter weather, being in daily operation and giving the greatest satisfaction.

It has been found that the conduits do not accumulate dirt, that the loss of current is not greater than on an overhead trolley, and the conduit has proven self cleaning, by the flushing of rain. Manholes are placed along the line, never less than 350′ apart. At these are sewer connections for carrying off the water.

A very noticeable feature of underground electricity is the smoothness of operation of the cars. Being entirely under control of the motormen, they run without the cable jerk, and the transfer has been a decided improvement.

The mechanical equipment of the Broadway lines may well be considered perfect, yet there remain serious faults in the service, which can hardly be remedied. The cars run with a very small headway, so that when a car is disabled others pile up behind it with surprising rapidity. The writer well remembers being tied up in such a "block," as it is called, and on walking ahead three squares, finding a line of fire hose stretched across the street. Cars from the other direction fared similarly, making in all a string ten blocks long—a curious sight to any but a New Yorker. On another occasion an automobile break-down caused the same effect. Heavy trucks with obstinate drivers often delay the cars. Passengers have no guarantee that they will arrive at their destinations within a reasonable time. Last Labor Day it took a car forty minutes to plow through less than half a mile of the parade, and excitement of this kind always delays the cars.

It is the policy of the company to run cars just often enough that they will always be well filled. During the rush hours, however, there are usually about two carloads piled into each car.

Just what effect the completion of the subway will have on the surface lines is hard to say at this early date, but it will surely relieve the morning and evening crush, and take traffic away from all other lines. Yet, it is safe to say that they will still be well patronized. Their cars will still be filled, and on a spring or summer evening, when the streets are comparatively deserted, these Broadway cars will be as popular as ever.

THE SENIOR TRIP.

BY ONE OF THE FORTUNATES.

THE much talked of Senior trip is a thing of the past, yet many are the fond recollections that the Seniors will carry with them even in the down hill of life.

The party of twenty-eight Seniors, accompanied by Dr. Gray and Professor Peddle, left over the Pennsylvania road at 5:10 Tuesday evening, May 5th. The President of the class must have gotten his "Irish up," when making arrangements for the trip, for he engaged the Pullman Emerald as the special car to transport the party. The evening on the train was spent in playing cards, reading, smoking, and many other forms of amusement that only a crowd of students can devise. Finally, after all had become weary of their pastimes, quiet reigned, and Morpheus ruled supreme. It was only for a short time, however, for he was dethroned about five o'clock by one of the Seniors, who took upon himself the duty of going to each birth and awakening the occupant with "Fellows, you had better arise and prepare your toilets, for we will shortly enter Pittsburg." We did finally enter Pittsburg about eight o'clock, eastern time, the train having lost an hour and a quarter *en route*. Many there were who were greatly worried that they had lost an hour's sleep, due to the change from central to eastern time.

The party was met at the station by a large delegation of Alumni, who received all most heartily. Some of these looked after sending the baggage to the hotel, while others had the small tables in the station restaurant thrown together into one large center table, and saw that all were properly refreshing the inner man preparatory for the day's jaunt.

Immediately after breakfast the party, and many of the Alumni, under the leadership of Mr. McTaggart and Mr. Wiley took the street car for the Duquesne Steel Works. Here the party was met by Mr. Wales, and immediately proceeded upon its inspection of the works. Starting in where the giant travelling cranes were removing the Hemitite from the roasters and piling it up in great heaps that are drawn upon as the ore is needed, the party passed on to where the little steam locomotives were drawing trains of cars that were being loaded with ore, flux, etc.; followed these trains as they rapidly delivered their freight to the mixers; on to where the big ingots are formed ; then noting the course of these ingots, which are about twenty inches square in cross section, through the various rolls, the speed of which increases as the metal decreases in size, until it comes out a finished rail. Thus was every feature of one of the world's greatest steel rail factories brought before our eyes.

After completing the tour of the Dequesne Steel Works the party was conducted to the Rankin Power Station. This is one of the street car power-houses, and is also utilized for lighting a large district. In this station are nine large, direct-connected Westinghouse generators. The steam for running these engines is generated in nine batteries of two boilers each, all of which are equipped with mechanical feed. In the generator room every thing was as neat and clean as a new pin, and these nine large generators whirling at a high rate of speed presented a very imposing sight.

The party now repaired to the Homestead Steel Works Hotel, where a very sumptuous banquet had been prepared, and at which we were the guest of the management of the Homestead Steel Works. After all were seated around the festive board Mr. Wales introduced Mr. Williams, Assistant to the General Superintendent, who delivered a short address of welcome. After all had partaken most heartily of the good eatables and drinkables, and had settled back to enjoy the cigars, President Palmer arose and, in a very neat little speech, expressed for the class their appreciation of the reception and courtesies that had been shown. To this Mr. Williams replied, and in closing stated that the electrical department, in which are several Rose alumni, had been dismissed for the afternoon, and were now waiting to conduct us through the Homestead Works.

In crossing the bridge that leads from the hotel, over the railway tracks, to the works, we noted many men carrying buckets of water. We were informed that this alone cost $15,000 per year. All of the drinking water being carried in this manner from the hill on one side to the men in the works on the other. Here we of course found much that was similar to the Dequesne work, but also much that was different. The large Bessemer converters, shooting their flames high into the air, were very interesting, indeed. These, together with the hot streams of steel that were being poured into the ingot molds, presented a view that one could indeed easily picture as "Hell with the lid off." Yet through all of this we followed our guides and feared no danger.

We took a peep at the open-hearth furnaces, at the rolling of channels and I-beams, and then crossed the Rankin bridge, which is the heaviest span in the country, to the Carrie Furnaces. Just after crossing the bridge we ran upon a very interesting machine, indeed. It was a modern car dumper. The loaded car was run upon the machine, fastened in place, and gradually the machine tilted the car upon its side until all of the contents were dumped out, then returned the car to its place upon the tracks. After visiting the Carrie Furnaces we were led back by way of the armor-plate mills. In rolling these plates, common rock salt is thrown upon the plate, this, upon entering the rolls explodes violently, blowing off the scale.

After leaving the Homestead Steel Works we went over to the Howard Axle Works, arriving there just at six o'clock, as the night shift was going to work. It took but a little while to follow up the course of a railway car axle, and the tired and foot-sore crowd were soon wending their way towards the car for the city. The car was pretty well filled, but this did not hinder the boys from being seated. One secured a seat in the front end of the car and with this as anchorage the fellows formed a row extending the entire length of the car isle, one sitting in the lap of another. This served very well until one of those sharp curves, that wind around the hills of Pittsburg, was struck at full speed. You can well imagine what happened.

The alumni would insist in paying the car fare of the entire party upon all occasions This was very nice in them indeed, but we must admit it was rather cruel towards the conductors, for they would have to rest several times before they succeeded in "ringing up" the thirty-five or more fares.

Finally we reached the hotel, cleaned up and obtained supper. This seemed to refresh all to such an extent that most of the party were soon out to take in the town—that is, as much of it as they could.

A big street railway convention was in session in Pittsburg and the hotel was crowded, making it necessary to put our party in two large parlors. These, with their long rows of beds presented very much the appearance of a hospital. All were so tired and sleepy, however, that those who "turned in" late disturbed but few.

The Mechanicals and Electricals were awakened about 5:30 Thursday morning so that all might get ready to catch an early train for East Pittsburg. Here the party was met by Messrs. Moore and Johannesen, and by Mr. Downton, head of the student department of the Westinghouse Electrical and Manufacturing Company, with quite a number of technical graduates, thus affording a guide for about every two men of our party so that every feature could be fully explained to all.

Upon entering the large erecting and testing building the first thing to attract our notice was three large generators that are being built for the New York Subway. The frames of these giant machines stand forty feet high, the diameter of the rotating part being about thirty feet. One of the most interesting features in this department was the ease with which the large tools could be carried about the establishment from one piece of work to another. In some instances as many as three or four of these large tools were being used simultaneously on one piece of work.

In the second story of this building we found most of the "workmen" to be girls. There being about 1500 of these variously employed in operating machines for separating and grading the mica, gluing the mica into sheets, wrapping the coils with tape, and winding coils of all sizes, kinds and shapes.

In the transformer department we saw in course of construction transformers of all sizes. Many of us were greatly surprised to see that after the laminations of even the largest transformers were built up they were screwed to place by hand, and not pressed by a hydraulic press, as many supposed would be the case.

We could easily fill the space alloted for this write up with a description of the many interesting things seen in this Westinghouse plant, for we were shown through the switch board department, power-house, forge shop, etc., and every where our attention was directed to the most minute details, even to the making of files by hand, but we must remember that "there are others".

After leaving the electrical plant we went through the Westinghouse Machine Works, where the Westinghouse engines are built. Noted the pits in which the large castings are made, the giant planers and trip-hammers at work, and walked through cylinders in which even Rumbley and Fitzpatrick could stand erect.

We were now invited to an informal dinner at the Westinghouse Club. It was easy to note with how much more vigor the fellows mounted the, hill to the Club than they had been showing on level ground for the past hour. After dinner and a short rest, we took the car for Wilmerding, the location of the Westinghouse Air Brake Works.

Here, as was the case in most of the plants visited on the trip, electrical transmission of power is used. In the power-house of this plant one finds, in addition to the ordinary types of gener ators, four Westinghouse turbo-generators running at their extremely high rate of speed.

Possibly the most interesting part of this plant was the foundry. Several continuously moving sidewalks, so to speak, run the entire length of the building, make a turn and complete a circuit upon themselves. Along one side of this moving table are placed the molding machines. One set of men will take an empty drag from the table, place it on the molding machine, fill it with sand, make the mold and replace the drag upon the table. Another man is ready with the cores, which he puts in position, and by the time the drag has reached the next molding machine the cope, which has gone through the same operations as the drag, is ready to go in place. A little further on the pourers with their ladles of molten metal, swung from a track above that leads to the cupola, fill the molds as they pass. At the other end of this moving table the molds are opened and the sand emptied over a conveyer that mixes and moistens the sand so that it is soon ready for use again. The empty flasks are replaced upon the table and again start on their round.

After seeing many other interesting things in the manufacture of Air Brakes the party returned to the city, reaching there about six o'clock.

On Thursday the Civil section, under the guidance of Messrs. Carr, Stone and Leser, visited the office of Mr. Geo. T. Barnsley, Resident Engineer of the Wabash R. R., who showed them the plans of the new cantilever bridge now building over the Monongahela. After inspecting the temporary but very complete cement testing laboratory, they examined the new bridge, or rather, the piers and the falsework in construction. They then proceeded across the river, and examined the tunnel, now under construction just at the end of the bridge. A detailed description of this work may be seen in the anniversary number of the Engineering Record of this year. The new passenger station of the Lake Erie and Western was next admired, and then all repaired to dinner.

In the afternoon, under the direction of Mr. Leser, various improvements now being made by the Pennsylvania R.R. were visited, among them the new Fort Wayne bridge, the terminal facilities, and the connecting of the Pennsylvania with the P. C. & Y. Here Mr. Leser has direct charge of extensive grading operations, much of the work being done by blasting and steam shovel. An interlocker was also visited, and some idea of the working of the levers was obtained.

On the morning of this same day the Chemists headed by Mr. McTaggart visited the Atlantic Petroleum Refinery. The plant was an old one but served to give an idea of how the oil was treated. About ten thousand barrels of the different grades of oil are turned out each week at this plant. The Duquesne Reduction Works were next visited and the trip through this small plant was most interesting. Here all kinds of scrap metal such as zinc, tin, lead and copper, and brass, solder and other alloys are treated so as to give the pure metals in some cases or to give salable alloys in other cases.

In the afternoon Mr. Craver took the Chemists through the laboratory of the Park Steel Co., and through the Pittsburg Testing Laboratory.

On Friday morning Mr. Howard Craver accompanied the boys to McKeesport where the works of the Pittsburg Gas and Coke Co., were visited. The coke is made here in the Hoffman by-product oven and was one of the first plants of this kind to be equipped in this country.

While the Chemists were at McKeesport Friday morning the Mechanicals, Electricals and Civils made a trip of inspection to the McKee's Rocks plant of the Pressed Steel Car Company. As the work of this plant was described in a recent issue of the TECHNIC, we will not comment further than to say that in the erecting department our attention was riveted all the time.

Friday afternoon a hurried trip was made to the American Locomotive Works, but as most of the students were anxious to see the game of base ball between the Pittsburg and Cincinnati National League teams, but little time was spent here.

At 9:15 that evening good-bye was said to our elder brothers, who had shown us such a splendid time, and we were soon speeding westward in the Zeda. Then it was that such songs as "Home, Sweet Home" were in order. We awoke the next morning in Indianapolis, where most of the party spent the day, returning to Terre Haute that night.

ORCHESTRA CONCERT.

The concert given by the Poly orchestra, at the First Congregational Church on the evening of May 12, is now filed away in the memory of nearly all the students and scores of others who were fortunate enough to attend. The church was filled with an appreciative audience and every number of the program received a hearty applause. The program opened with the overture, "Ivanhoe," which was artistic and pleasing. It was enchored with "Clash of Arms." The violin playing of little Miss Ione Hazledine is little less than phenomenal. She responded to the audience's call for more with "Perpetual Motion." Ralph Blanchard, '05, sang "Bendemeer's Stream" very well. The "Russian Sleigh Song" was the most appreciated of the orchestra numbers and was enchored by "The Bogie Man." Everyone enjoyed, to the fullest extent, the violin solos, "Fantaisie on Mignon" and "Serenade by Pierne," which Mr. Hugh McGibeny rendered in his characteristic manner, and also the Monologues by Mrs. Hugh McGibeny, especially "Speak up Lize," by Dunbar.

The program closed with the "Valse Espagnole, La Teracita," which had the tamborine and castanet effect, peculiar to Spanish music. This was the first concert given by the Orchestra unassisted by the Glee Club and was a complete success. When they give another they will undoubtedly be compelled to find a place which has a larger seating capacity.

The program was as follows:

PROGRAM.

Overture, Ivanhoe . . . . Edward Hazel
ROSE POLYTECHNIC ORCHESTRA.

Violin, First Air Varie . . . . De Beriot
MISS IONE HAZLEDINE.

Vocal, Bendemeer's Stream . . . . Gatty
MR. R. C. BLANCHARD.

March, The Jolly Student . . . . H. H. Zickel
ROSE POLYTECHNIC ORCHESTRA.

Violin, Fantaisie on Mignon . . . . Sabaste
MR. HUGH MCGIBENY.

Russian Sleigh Song . . . . E. S. Thornton
ROSE POLYTECHNIC ORCHESTRA.

Monologues,
(*a*) Colored Regiment Band . . . . Stanton
(*b*) Foolish Little Maiden . . . . Anon
(*c*) The Tin Gee Gee . . . .
MRS. HUGH MCGIBENY.

Valse Espagnole, La Teracita . . . . . . Renwar Borsey
ROSE POLYTECHNIC ORCHESTRA.

THE GAME WITH DANVILLE NORMAL.

The base ball team won its first scheduled game of the season from the Central Normal College of Danville, Indiana, by the one sided score of 21 to 6. The score should (or would) have read 21 to 0 but the team simply could not play first-class base ball with such a team against them. However, the game developed the fact that the fellows have good team work and play together well—a fact that is of vital importance in the winning of a ball game. Reed showed up the best for the home team, making four hits out of five times at bat. Demmitt's run getting was a feature, as he made five runs out of six times up. Incidentally he managed to get a two base and a three base hit.

With Daily in the box for Rose, Flint knocked a sky scraper to Bowsher, who dropped it. Turner's grounder to Demmitt forced Flint at second. O'Brien and Riggins each singled, bringing in Turner. Lasater struck out. Bidwell hit, bringing in O'Brien, when Mitchell ended the agony by striking out. Two runs.

For the Poly, Reed started the ball rolling by getting hit, stole second and came home on errors by Mitchell and Riggins. McBride was safe on error at first, scoring Bowsher. Freudenreich flied out to center, scoring Demmitt. Bland was safe on error, Cox out on grounder, and Cushman knocked a high one to Mitchell, ending the side. Five runs. No scoring was done by the Normalites again until the sixth inning, when they bunched their hits and scored three runs.

A detailed description of how Poly scored her runs would be tiresome, as they scored in every inning but one. There is one thing the team is to be congratulated on and that is the absence of balloon ascensions. Several games were lost last year for that very reason, but we feel confident that such will not be the case this year.

ROSE.

	A.B.	R.	H.	S.H.	P.O.	A.	E.
Reed, c	5	2	4	0	11	0	0
Bowsher, lf	5	1	0	1	0	1	2
Demmitt, 3d b.	6	5	2	0	0	2	0
McBride, 1st b.	6	3	0	1	8	0	1
Freudenreich, 2d b.	6	1	1	1	2	4	0
Bland, cf.	5	2	2	0	2	1	0
Cox, ss.	2	1	0	0	3	1	2
Cushman, rf	4	2	1	0	0	0	0
Daily, p. and ss	5	3	1	0	1	1	1
Braman, p.	0	1	0	0	0	1	0
Total	44	21	11	3	27	11	6

CENTRAL NORMAL.

	A.B.	R.	H.	S.H.	P.O.	A.	E.
Flint, lf.	5	1	3	0	0	0	0
Turner, cf.	4	1	0	1	2	0	0
O'Brien 3d b.	5	1	1	0	1	1	0
Riggans, 2d b.	3	1	1	0	1	4	3
Lasater, c.	5	0	0	0	7	0	0
Bidwell, ss.	5	0	2	0	0	0	5
Harding, rf	5	1	1	0	0	0	0
Mitchell, 1b	4	0	2	0	12	0	2
Hammock, p.	4	1	2	0	1	3	1
Total	40	6	12	1	21	8	11

Two-base hits—Freudenreich, Demmitt.
Three-base hit—Demmitt.
Double play—Bland to McBride.
Bases on balls—Braman 1, Hammock 4.
Hit by pitched ball—Reed.
Struck out—By Daily, 6; by Braman, 3; by Hammock, 5.
Innings pitched—Daily, 5; Braman, 4; Hammock, 8.
Umpire—McKenzie.

The base ball team has proved itself worthy of the heartiest support and patronage from the entire student body, and it should have the same.

If we expect to win from Wabash college when we play them at Crawfordsville on May 30th, we must take along a crowd of rooters to help cheer the team along. So, let every fellow save his money and go along to cheer 'old Rose' to victory.

ROSE PLAYS LAW SCHOOL.

INDIANAPOLIS, May 9.

Rose Polytechnic was taken into camp to-day by the Indianapolis Law School by the score of 4 runs to 3 in a ten inning game. The feature of the game was the poor work of the umpire who acted as if he had never seen the inside of a rule book before. The Poly team made twice as many hits as the home team, and less errors, but could not win out. A rank decision on first base, in the sixth inning, was when the umpire donated the game to the locals. This, coupled with balls that were called strikes on the Poly batsmen and strikes that were called balls on the Law School proved to be too great an obstacle for the Rose team to overcome. It can be safely said that the Poly team has rarely ever been subjected to such unsportsmanlike conduct as they were in the game to-day.

Reed opened the game with a hit to right but died on first, as both McBride and Dimmitt struck out and Bowsher knocked an easy grounder to Smith.

In the second inning the first man struck out, Bland singled and reached second on an error in left field. Daily flew out and Cushman fanned.

Stoddard beat the air vainly three times and Reed was thrown out at first. McBride fanned.

Demmitt was called out on strikes by the umpire. Bowsher walked, stole second and scored on Freudenreich's hit to right. Bland beat out a slow one to Smith who threw wild in an attempt to catch him. Freudenreich scored on the throw.

Bland scored on a hit by Cushman, who was thrown out on an attempt to steal second.

In the fifth Stoddard apparently hit safely to right but the first baseman jumped high in the air and caught the ball with one hand. Reed sought in vain for the ball and McBride singled but was thrown out in an attempt to steal second.

Demmitt struck out and Bowsher batted a high one to left which, unfortunately, fell into the hands of the fielder. Freudenreich hit and Bland was safe on error at second, but Daily in his anxiety to bring in a run swung hard at the ball but instead of a home run knocked a high foul which was easily caught by Springer.

Cushman was out at first and Stoddard flew out to third. Reed got a base on error at first but McBride was out on a "pop up" to Seal.

Demmitt hit safely, stole second and third. Bowsher was safe on error by Seal, who stopped the ball but did not touch his man. Freudenreich flew out to first. Bland struck out and Daily again was out on a foul fly.

Cushman and Stoddard both knocked easy grounders but Reed hit and advanced to second on McBride's hit. Demmitt was out on a hard fly to center which was caught by the fielder just as he tripped and fell.

Bowsher hit safely in the tenth but could do nothing, as the next three men went out in order.

Law School scored in first on a two-base hit by Pettijohn, followed by a single one by Smith.

Again in the sixth another run was scored. A ball was batted along the third base line that looked like a sure hit. Demmitt got it however and made a good throw to McBride. However, the umpire thought he saw "Mac's" foot off the base and called the runner safe. Smith made a three bagger to left but died on third.

In the eighth, with two out, McBride muffed a hard throw and when he recovered the ball the man was safe on second. Quisser hit to right, scoring the other runner.

In the tenth, with the score tied, Kealing got in the way of a slow one and was safe at second on an error by Demmitt who threw poorly to second in attempting a double play. A hit by Pickens to left field brought in the winning run and the game was over.

ROSE.

	A.B.	R.	H.	P.O.	A.	E.
Reed, c	5	0	2	13	1	0
McBride, 1b	5	0	1	13	0	1
Demmitt, 3b	4	0	1	0	3	1
Bowsher, rf	4	1	1	1	0	0
Freudenreich, 2b	5	1	2	1	1	0
Bland, cf	5	1	2	0	0	0
Daily, P.	5	0	0	1	4	0
Cashman, lf	5	0	1	0	0	1
Stoddard, ss	4	0	0	0	3	0
Total	42	3	10	29	12	3

LAW SCHOOL.

	A.B.	R.	H.	P.O.	A.	E.
Pickens, 2b	5	1	1	3	2	1
Pettijohn, cf	5	2	1	1	0	0
Quisser, 3b	4	1	1	0	3	0
Smith, p	4	0	2	2	4	1
Seal, 1b	4	0	0	10	1	2
Springer, c	4	0	0	12	3	0
Barrett, ss	4	0	0	0	1	0
Kealing, lf	3	0	1	1	0	1
Jackson, rf	4	0	0	1	0	0
Total	37	4	6	30	14	5

SCORE BY INNINGS.

	1	2	3	4	5	6	7	8	9	10	R.	H.	E.
Rose	0	0	0	3	0	0	0	0	0	0	3	10	3
I. L. S.	1	0	0	0	0	1	0	1	0	1	4	6	5

Two out when winning run was scored.
Stolen bases—Demmitt, 2; Bowsher, 2. Bland, 1; Ind Law School, 2.
Bases on balls—Off Smith, 2.
Two-base hit—Smith.
Three-base hit—Smith
Hit by pitched ball—Kealing.
Struck out Daily, 13; Smith 12.
Umpire—Scott.

WABASH 3; ROSE 5.

In one of the prettiest games ever seen on the "Poly" campus the Varsity base ball team defeated Wabash college by the close score of 5 to 3. It was a pitcher's battle from start to finish, and the best man won. Both pitchers had gilt edge support behind them, while the fielding of Demmitt was the star attraction of the game. His catch of a foul fly far back of the third base line with two Wabash men on bases and when a hit meant a run, was the best play in a good game and was mainly instrumental in saving the day for Rose.

Wabash scored first blood in the first on a man hit, a steal and a clean single to left center. After that Daily settled down and no more men crossed the plate for Wabash until the fourth inning when Boulton's hit coupled with two errors and a wild pitch scored two runs.

For the Poly, Reed led off with a hit but was forced out at second on Bowsher's grounder to short. Demmitt flied out to second base and McBride knocked an easy grounder to Fisher.

In the second, Freudenreich was out on a grounder to pitcher, Bland walked and stole second, but was out on a double play when Cox knocked a liner into Kane's hands.

During the next inning the Poly boys fell on Fisher's delivery for five hits and when the smoke had cleared it was found that five Rose players had crossed the plate.

Cushman hit and was advanced to second on a neat liner by Daily towards third base. However the third baseman handled the ball badly and both the runners were safe. Reed was out on a "pop up" to second base but Bowsher lined out a beauty between short and third and the left fielder threw wild at home in an attempt to catch Cushman. This allowed Daily to score and Bowsher to reach third base. Demmitt got one to his liking and sent the sphere to the tennis court, landing on second base. McBride hit safely advancing Demmitt to third. "Mac" stole second and came home on Bland's single to right field. Cox fanned the air three times and ended the inning.

After this there were no more chances to score as Fisher kept the hits too well scattered to be dangerous.

ROSE.

	A.B.	R.	H.	S.H	P.O.	A.	E.
Reed, c	4	0	1	0	9	3	0
Bowsher, l. f	4	1	1	0	0		0
Demmitt, 3rd b.	4	1	1	0	2	2	1
McBride, 1st b.	4	1	1	0	5	1	1
Freudenreich, 2nd b	4	0	0	0	7	1	1
Bland, c. f.	2	0	1	0	1		0
Cox, s. s.	3	0	0	0	1	2	1
Cushman, r. f.	2	1	1	0	1		0
Daily, p.	1	1	1	2	1	2	0
TOTALS,	28	5	7	2	27	11	4

WABASH.

	A.B.	R.	H.	S H.	P.O.	A.	E.
Davies, c. f.	3	1	0	0	1	0	0
Coen, c.	4	0	3	0	7	4	0
Boulton, 3rd b.	4	1	1	0	0	0	1
Podush, r. f.	3	1	1	0	1	0	0
Thornell, 2nd b.	4	0	0	0	5	2	0
Hasbrook, l. f.	3	0	0	0	0	0	1
Kane, s. s.	3	0	0	0	1	3	0
Williams, 1st b.	4	0	1	0	7	0	0
Fisher, p.	2	0	0	0	2	2	0
Total	30	3	6	0	24	11	2

SCORE BY INNINGS.

	1	2	3	4	5	6	7	8	9	R.	H.	E.
Rose	0	0	5	0	0	0	0	0	0	5	7	4
Wabash	1	0	0	2	0	0	0	0	0	3	6	2

SUMMARY:

Stolen Bases—Bland, Boulton

Sacrifice hits—Daily (2).

Bases on balls—Off Daily 3, Off Fisher 2.

Two base hits—Demmitt.

Double plays—Kane and Thornell, Demmitt, Freudenreich and McBride.

Hit by pitched ball—Kane.

Struck out—By Daily 8, By Fisher 5.

Umpire—Scott.

ROSE—NORMAL FIELD MEET.

Saturday, May 9th, was a perfect day for a field meet. There was not a breath of air stirring and the thermometer registered about 80 degrees. The events started with the 100 yard dash and resulted in a start of nine points for Rose. Turk crossed the tape first, Lee second, and Willien third. The Rose rooters started right here to get in some fine work and from this event on the cheering on the part of the Tech fans was of the best. Hazard, '04 led in the yells and ran them through in quick time and fine form. The support given to the team throughout the entire meet was fine and should have been a lesson in cheering to the Normals. The half mile followed as second event and once more the grand stand went mad as Hahn took first and Johnson followed about two feet behind for a close second place. In the standing broad, Turk with first and Randal with second place added eight points to our score. Willien, A. Lee and Larkins tied in the pole vault and shut out the Normals completely. So far so good and all were happy. Then the 220 yard hurdles was announced and all were uncertain as to the result. As we had no hurdles to practice on it was feared that the Normals might monopolize this event. At the crack of the pistol the entire crowd rose to their feet and remained standing until all of the three heats were over. First place went to Normal, but Peddle and Modesitt did fine work for us and obtained second and third. We were somewhat surprised to win all three places in the running high jump and the yell was given with a vim when Turk, Wischmeyer, and Peddle were announced as having won first, second, and third. Next followed the 220 yard dash and it was pretty to look at. Turk, set back two yards, won first easily and in good time, while A. Lee, set back one yard, crossed the tape a good second. Total score now stood Normal 8; Rose 55. The Normals received quite a surprise in the discus hurl. Turk, being first up, hurled the weight about 84 feet, and he was followed by a Normal man who managed to toss the discus 91 feet 9 inches. The Normals went mad over this and hats and banners of blue were waved overhead, while the Poly rooters smiled up their sleeves and just waited. "Is that all you can do?" said a Normal contestant to Turk. "Next time I'll throw it over a hundred feet," said Turk and he was soon given a chance to make good his word. With a pretty turn the weight left his hand and sailing nicely through the air struck at 103 feet, 5½ inches. There is no need to tell which side did the yelling when this record was announced. Peddle took first place in the high hurdles in great form and Modesitt made third. In the shot put Byers was awarded first at 33 feet, 1 inch. Turk put the shot at 34 feet but was judged as having fouled so was only allowed second place at 32 feet, 11 inches. A. Lee added three more points by getting a close second in the quarter mile, and Turk won first in the running broad at 22 feet, 1 inch. This is three-quarters of an inch behind the state record and if it had not been that the event was at the end of the program, it is certain that Turk could have made 22 feet, 2 inches. The events ended with the mile run and in this Hahn gave us one of the most sensational and one of the prettiest finishes that we have ever had the chance to witness. At the ⅞ths post Bryce of Normal was fully fifty yards ahead of Hahn. His own men assured him that he needed only to keep up his pace and he would win. But they had neglected to take into account what Hahn was going to be doing all this time and so Bryce was surprised to see Hahn pass him and cross the tape about one foot to the better. Hahn could have had anything he wanted after that race. As he was carried off the track he waved his hands to the rooters in the grand stand and seemed to still have good wind. Lawton made a pretty finish and took third place. Captain Turk showed up finely, and taken as a whole the team's work was very good.

OFFICIALS.

Starter:—Prof. J. P. Kimmell, I. S. N.

Referee:—Charles McCormick, R. P. I.

Judges:—Prof. A. S. Hathaway, R. P. I.; Prof. F. J. Weng, I. S. N.; Prof. A. M. Patterson, R. P. I.

Timers:—Prof. W. P. Morgan, I. S. N.; Prof. E. S. Johonnott, R. P. I.; Prof. O. P. Dellinger, I. S. N.

Measurers:—Prof. R. L. McCormick, R. P. I.; Prof. Robert R. Gillum, I. S. N.; Wm. R. Heick, R. P. I.

Scorer:—E. H. Bauer, R. P. I.

Clerks:—H. S. Kellogg, R. P. I.; R. R. Fair, I. S. N.

Announcer:—J. B. Hessong, I. S. N.

RESULTS.

100 Yard Dash—1, Turk, R. P. I.; 2, A. Lee, R. P. I.; 3, Willien, R. P. I. Time 10$\frac{2}{5}$ sec.

Half Mile Run—1, Hahn, R. P. I.; 2, Johnson, R. P. I.; 3, Sanders, I. S. N. Time 2 min. 12$\frac{3}{5}$ sec.

Standing Broad Jump—1, Turk, R. P. I.; 2, Randal, R. P. I.; 3, Beecher, I. S. N. Distance 10 feet.

Pole Vault—1, Willien, R. P. I.; 2, A. Lee, R. P. I.; 3, Larkins, R. P. I. Height 8 ft. 4 in.

220 Yard Hurdle—1, Kitch, I. S. N.; 2, Peddle, R. P. I.; 3, Modesitt, R. P. I. Time 29$\frac{3}{5}$ sec.

Running High Jump—1, Turk, R. P. I.; 2, Wischmeyer, R. P. I.; 3, Peddle, R. P. I.; Height 5 ft. 2½ in.

220 Yard Dash—1, Turk, R. P. I.; 2, A. Lee, R. P. I.; 3, Probst, I. S. N. Time 22$\frac{1}{5}$ sec.

Running Broad Jump—1, Turk, R. P. I.; 2, Kitch, I. S. N.; 3, Probst, I. S. N. Distance 22 ft. 1 in.

Mile Run—1, Hahn, R. P. I; 2, Bryce, I. S. N.; 3, Lawton, R. P. I. Time 5 min. 17$\frac{2}{5}$ sec.

Result in Points—Normal, 34; Rose, 83.

You may find a balm for a Lover crossed,
  Or a candidate defeated,
But the only balm for a ball game lost
  Is to say that the Umpire cheated.

Turk jumped 22 feet in practice recently. This is within 1¾ inches of the state record and should undoubtedly win first place in the state meet at Richmond, on May 16th.

The second team played a picked team from Brazil on the afternoon after the Wabash game. The Poly team was never in the running, the final score being 7 to 0 in favor of Brazil.

Mr. L. A Touzalin has been elected manager of the track team to succeed C. C. McCormick, resigned. Mr. Touzalin is well fitted for the position as he is a willing worker and knows his business thoroughly.

OTHER COLLEGES.

BASE BALL.

At Bloomington—Indiana University, 3; DePauw, 2.
At Philadelphia—Yale, 5; Pennsylvania, 2.
At Greencastle—DePauw, 8; Notre Dame, 7.
At Ithaca—Cornell, 10; Princeton, 3.
At Cambridge—Harvard, 8; Williams, 2.
At Beloit—Notre Dame, 12; Detroit, 6.

In a dual field meet between Wabash College and Indiana State Normal, Wabash won by the overwhelming score of 98 to 18. Reed, of Wabash, ran the mile in 4:51.

Powell, of Purdue, throws the discus 111 feet 6 inches. This beats the state record and comes near the western record.

In an inter-class field meet at Purdue, the Sophomore class won, with the Freshmen a close second.

O'Neill, who caught for Notre Dame last year, is coaching I. U.'s base ball team.

DePauw University will play Wabash College, on Thanksgiving, at Crawfordsville.

It's taken Spring quite a little while to arrive but its here at last.

Come out to the base ball games and you'll wear "the smile that won't come off."

One—a—strike—a
Two—a—strike—a
Three a—strike—a—out
Get off the base, go chase your face
For Daily 's struck you out.

Soph:—How is your Scientific Society getting on?

Junior:—Fine, thank you; Noodles Hahn's problem yesterday was to "find the height of a man given the atmospheric pressure."

Wischmeyer has been elected treasurer of the class of 1906, to fill Hodge's place. Turk succeeds Eppert as an athletic director of 1906.

Twenty-four fellows left for Lafayette (not flunks) on April 25. They were partly the team, partly rooters, on their way to beat Purdue. The train left Terre Haute about 7:20 A. M. and just before starting time the train shed resounded with R. P., R. P. Now, you must know that a few miles east of this city there is a couple of barns and a house with a shed near, called a station, and painted on this shed in big letters is the name of the place. It is called Harmony. Well, the train was approaching this town (let's call it a town) when several of the fellows started up a song. It was all right at first but the first part was the only part they knew. We say this because we are judging from the sound, noise, or whatever you wish to call it, that resulted when they tried the second part. Several of the more sensitive passengers stuck their heads out of the windows. But, thank heaven, this little collection of sheds and one house came in handy, for just then the conductor walked in and putting his hand to his mouth bellowed forth, "Harmony, Harmony."

Welte, formerly of '05, has passed all his examinations, except the physical one, for Annapolis and expects to leave for there soon.

Hodge, formerly of '06, who returned home on account of ill health, was in town a few days to settle up his affairs.

Goode, who took the last term of Freshman work at Rose last year, has been visiting his Poly friends.

A GIRL.

You can teach her to paint, to embroider, and sing,
To ride on a bike and to make lemonade;
You can teach her to love you, the dear little thing!
But you never can teach her how base-ball is played.
—[Ex.

Prof. Wagner:—You have designed a boiler which will just collapse.

McCormick:—That's all right, Professor. I wasn't going to run it.

Landrum (translating French):—His daughter was singing on a dilapidated piano.

Soph·—There goes an albino.

Goodman:—What is an albino, a Normal?

Prof. W.:—In Italy, in the old days, if a man had light hair he was considered noble.

Junior:—Tip would have been a god if he had lived at that time, wouldn't he?

The tennis courts are now in good condition and we ought to start a Spring tournament soon.

If you enjoy rooting and believe it is a good thing, why don't you show your interest by paying the entrance fee of fifty cents and becoming a member of the Rooters Club? During the season the club will probably send men to cheer on the team at their games away from home. See Brosius and give him your name.

ON THE RETURN FROM LAFAYETTE.

The train came to a standstill on a sharp curve. At first we thought that they were taking on water but after five minutes had elapsed and the train still showed no desire to start up we heard that there was trouble ahead and a delay would be necessary. Well we did several things to kill time and finally having become tired of talking all were silent. Just at this moment the door at the other end of the car opened and in walked the conductor. McBride suddenly sat up and holding out his hand said in a loud voice; "say conductor tell the engineer not to go around these curves so fast."

One interesting feature of the Normal-Wabash Meet, which was held May 2, at the Fair Grounds, was the series of specialties which took place between the events. In the eighth of a mile Clara D. won by two lengths, and the relay race, which was finished by Clara D. and Sly, resulted in a dead heat.

Freudenreich:—There was a cow at the Experimental Station at Purdue that gave buttermilk.

McBride:—Well, what could a cow give but-her-milk?

The Junior's have about concluded that the well known jingle given below fits Rankine pretty well:

If there should come another flood
  For refuge hither fly,
If all this world should be submerged
  This book would still be dry.

APRIL 2.

And the moon don't shine to-night so bright ta Wabash
  For they met the R. P. I. at ball to-day.
And the record they had won at other places
  Was abolished by the Poly men at play.

Words of wisdom:—Now in order to do this you must know how it is done.

Palmer:—Talk about your fast trains, you ought to see the Empire State Express, why two minutes after the train goes by, the shadow comes bumping along the ties. She's fast.

Jenckes:—What's that sign Professor?

Prof.:—That means function of. Do you know what a function is?

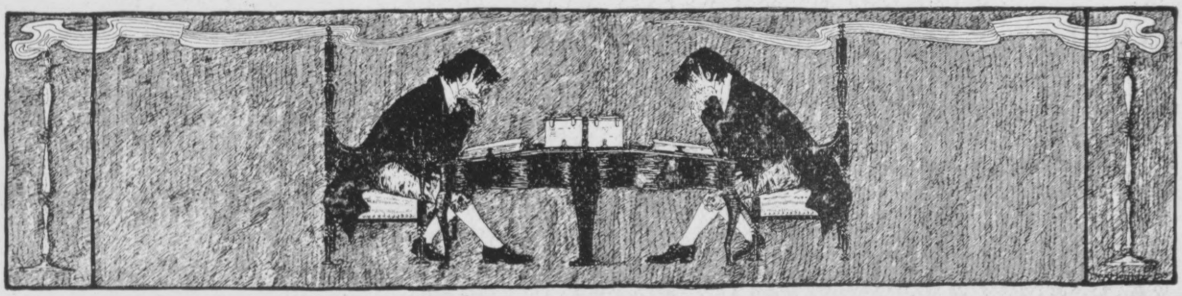
Jenckes:— Yes sir, its a social gathering.

Now this shows that the stone falls n^2 feet per second.

Robertson:—How can a stone fall square feet.

Falley:—Say, fellows, I'll bet fish would bite well to-day.

Prof.:—Well, if you work all those problems they won't bite you.



REVIEWS

PICH PROCESS OF BRAZING CAST IRON.

AT the regular monthly meeting of the American Society of Mechanical Engineers, April 7, Mr. J. S. L. Alexander read an interesting paper on the Pich Process of Brazing Cast Iron. The following appeared in the American Machinist as a description of the process:—

This process, as stated in the paper, is the invention of a German, named Pich, and has attracted much more attention in European countries than here; Krupp, among others, having used it in putting together very large castings. The author, according to his paper, first became interested in the process through seeing it used in repairing a large pump cylinder in Philadelphia; and he mentioned in the paper several other interesting examples of machine parts repaired by this process. The preparation used is known as Ferrofix, of which, as our readers will remember, we have made mention at several different times in our columns. This is a dark brown powder, and is really a metallic oxide, the action of which during the heating of the metal is to burn out the carbon in the vicinity of the joint. This powder is mixed with a liquid, and in the form of a paste is applied to the ends to be joined, these having been of course thoroughly cleaned. The parts are then brought together, the paste acting, in a way, as a cement to hold them in place; they are placed on suitable supports and the gas or other flame is applied as in ordinary brazing. The metal being brought to a temperature of about 1800 degrees Fahr., a flux—either powdered borax or some similar material—is applied, and then the spelter is put on. The brass used may be hard or soft, according to the material to be brazed. When property applied this covers the ends of the parts thoroughly, and a positive and smooth joint is the result. The spelter evidently penetrates the iron for some little distance, as traces of it have been detected (under a powerful glass) fully 3 inches from the joint. Some castings repaired by this process are chipped at the end to form new surfaces before applying the Ferrofix. In other cases where small parts are broken out, these parts may be replaced and brazed in their original positions. In Europe it seems many complicated castings have been made in sections and then brazed together, there being less liability of flaws in such castings and the completed work being stronger than if cast in one piece. Where a casting is cracked the preparation may be squirted in from an oil can, the work then being heated and brazed. Gears having one or more teeth broken out may be readily repaired, the teeth being put back and brazed in place. Mr. Alexander mentioned a number of interesting applications of the process, such as filling in blow holes in castings—by coating the cavity with Ferrofix, putting in spelter and then pouring in molten iron; brazing steel plates, large and small, to castings spongy or cracked; and brazing large machine beds which had cracked in service. A number of small cast-iron blocks which had been brazed were exhibited, and also a photograph showing a heavy shear which had cracked in a peculiar manner and which had been repaired by this process. He gave the cost of the preparation as being less than ½ cent per square inch of brazed surface. Cast-iron specimens tested before and after the brazing operation, it was stated, were increased in tensile strength from 5 to 10 per cent; the action of the preparation in removing carbon really converting the metal near the joint into a low grade of steel.

OIL TREATMENT FOR LEAKS IN CONCRETE.

From the Report of the Chief of Engineers, U. S. Army, 1902.

IN the fortification work at Fort Caswell, North Carolina, it has been found almost impossible, with the unstable subsoil, to prevent unequal settlement and consequent cracking of the concrete. Various schemes have been tried to stop the leaking produced by these cracks (waterproofing not having been used in the concrete walls), but to assistant Engineer S. F. Burbank, in local charge, is due the credit of a device which has resulted in an apparently complete solution of this difficulty. It was noticed that water falling on the concrete surfaces near the guns, which had been coated with the oil used on the guns, was not absorbed. This led to a coating of the entire concrete mass with boiled linseed oil. Where large cracks occur, they are filled with cement grout, and the linseed oil is poured in as long as it is absorbed. There is formed in the crack a gum from the oil which ultimately fills it to the top, after which the entire surface is coated with successive applications of the oil until it ceases to be absorbed.

Previous to the trial of this method the two 12-inch emplacements were notably leaky, and for the purpose of experiment the worst of the two was selected and treated as above outlined, with the result that it was made perfectly water-tight. Since then all of the emplacements of the post have been treated similarly, and may now be considered water-tight.

It is probable that it will be necessary to give a coating of oil, at least near cracks, when the concrete expands and contracts in the spring and autumn, but this will be comparatively inexpensive and take very little time. A gratifying result of this oil treatment is the prevention of the glare from the concrete surfaces, which heretofore has been particularly objectionable. The resulting color is a brown, which is restful to the eye and blends with the color of the surrounding sand hills, making the emplacements very difficult of detection from a distance.—*Engineering Record.*

MAGNETIC EQUIPMENT TO INCREASE TRACTION.

SOME interesting experiments have been made at Seattle, Wash., during the last two years on electric railway trucks equipped with devices for increasing, by means of magnetism, the adhesion of the wheel to the rail, or in other words, the traction.

On each side of the motor casing and the wheel is a bearing which supports an arm, upon which the magnetizing coil of wire is wound. The other end of the arm carries a wheel without a flange, which rolls along the rail when the device is in operation, and is held five-eighths of an inch above the rail by springs, when the coil is not energized. The object of this arrangement of an idler wheel upon the rail is to give a short magnetic circuit. The lines of force, in this case, of course, flow from the arm to the car journal and wheel, from the car wheel to the rail, from the rail to the idler, and thence through the coil-wound arm.

The effect of this mechanism, when the current of electricity converts it into a magnet, is to hold the car wheel to the rail with a force additional to that derived from gravity. With an expenditure of two and one-half electrical horse-power to magnetise the four coils, an increase of 350 per cent. in the tractive effort, is obtained, and, what is still more remarkable, the tractive effort does not fall off when the wheels begin to slide or spin, but, on the other hand, increases slightly. This is accounted for by the generation of eddy currents in the wheel and rail, when the slipping takes place.

In the tests at Seattle it was found necessary to grease the rails with axle grease in order to bring the slipping point of the wheels down to the limits of the motor capacity, when the magnets were energized. The draw-bar pull upon this greased rail, before the wheels began to slip was 1500 pounds. It was increased to 5250 pounds upon energizing the magnets.

It is proposed to use this device to increase the traction of steam and electric locomotives and motor cars. In electric railway operation, as it is conducted at present, probably the most valuable feature of this improvement is the increased braking power it affords for emergency stops, especially where the rails are slippery, and for controlling the cars on steep grades. F. B. L.

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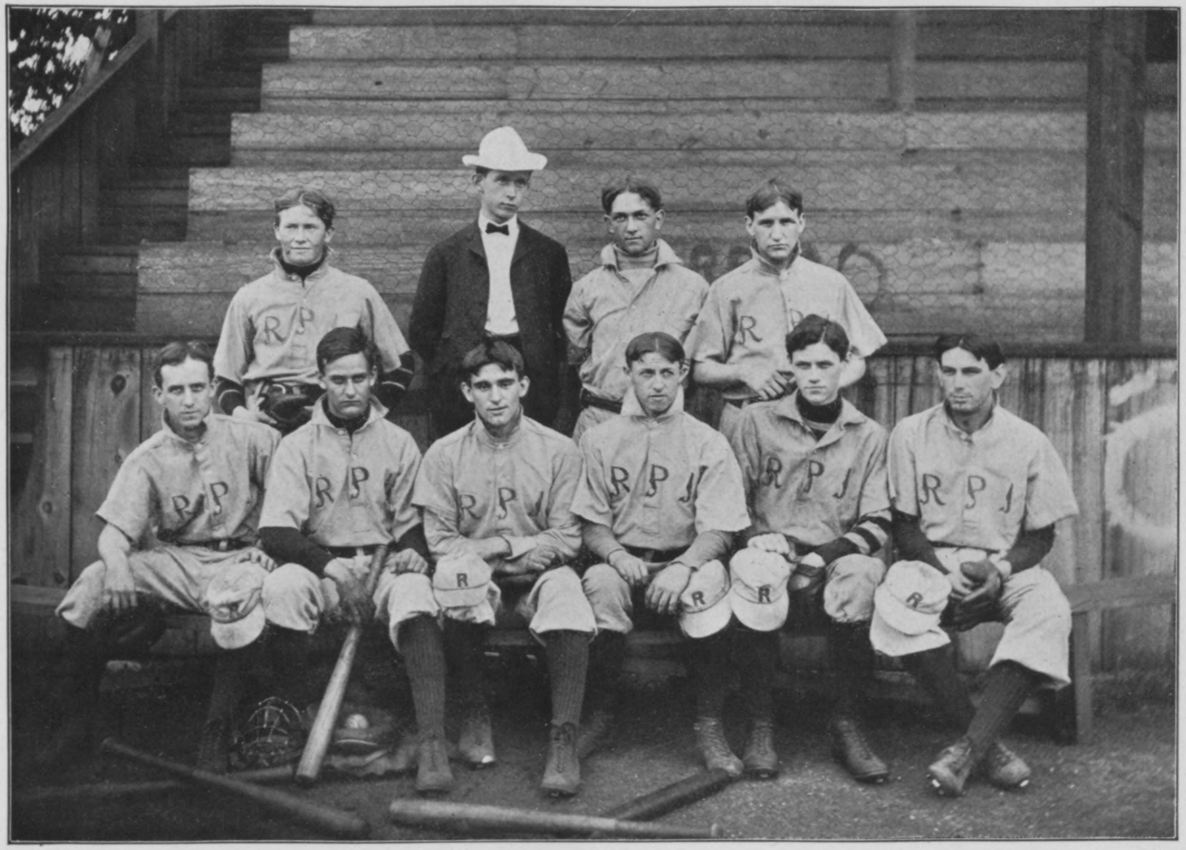

BASE BALL TEAM OF 1903

DEMMITT, 3d b. REGAN, Mgr. FREUDENREICH, 2d b. BLAND, c.f.

MCBRIDE, 1st base. REED, c. DAILY, p. (Capt.) BOWSHER, r.f. CUSHMAN, l.f. STODDARD, s.s.